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### Research Note

## Description and Host Relationships of Cystacanths of *Polymorphus spindlatus* (Acanthocephala: Polymorphidae) from Their Paratenic Fish Hosts in Peru

OMAR M. AMIN,<sup>1,4</sup> RICHARD A. HECKMANN,<sup>2</sup> RODOLPHO MESA,<sup>3</sup> AND EVA MESA<sup>3</sup>

<sup>1</sup> Department of Zoology, Arizona State University, Tempe, Arizona 85287-1501,

<sup>2</sup> Department of Zoology, Brigham Young University, Provo, Utah 84602, and

<sup>3</sup> Department of Biology, The University of High Plains (Altiplano), Puno, Peru

**ABSTRACT:** Cystacanths of *Polymorphus spindlatus* Amin and Heckmann, 1991, were collected from the body cavity of 4 species of killifish in the genus *Orestias* in Lake Titicaca, Peru, where adults were originally described from night herons. Infections were more common in the livers of *O. agassii* from open waters than from other hosts. Attachment structures of cystacanths were similar in size to those of adults but trunk, trunk spines, lemnisci, and reproductive structures were smaller than the same structures in adults. Cystacanths were encapsulated on the liver surface within hyaline envelopes and caused host hepatic tissue necrosis, disruption of hepatic envelope, and edematous liver cells.

**KEY WORDS:** *Polymorphus spindlatus*, Acanthocephala, cystacanth description, paratenic hosts, *Orestias* spp., killifish, Peru.

Since the description of *Polymorphus spindlatus* by Amin and Heckmann (1991), considerable effort has been invested in exploring additional host systems associated with the life history of this acanthocephalan. This report describes the anatomy of the cystacanth of *P. spindlatus* in its paratenic fish host system at Lake Titicaca, where adults were initially col-

lected from the definitive host, black-crowned night heron, *Nycticorax nycticorax* (Linnaeus, 1753). This report also describes host-parasite relationships at the histopathological level as well as in relation to host habitats and sites and frequency of infection.

Fish were captured between February and July 1991 and 1993 by gill nets and seines from Lake Titicaca in 2 locations. The first location was Puno Bay where adults were previously collected (Amin and Heckmann, 1991) and the other was the open deeper waters of the lake. Of 304 adult fishes of the genus *Orestias* examined fresh, 64 (21%) were infected with an average of 5.2 cystacanths per infected fish (range 1–8) in liver and intestinal serosa (Table 1). Thirty-three cystacanths were processed for microscopical examination, of which 26 specimens were morphometrically studied. The remaining material was sectioned in situ. Methods of processing both sets of samples are the same as those described by Amin and Heckmann (1991).

Ten males and 16 females were measured. Measurements are in micrometers unless otherwise noted; the range is followed by the mean in parentheses. Width measurements refer to maximum width. Body (trunk) length does not

<sup>4</sup> Reprint requests: Institute of Parasitic Diseases, P.O. Box 28372, Tempe, Arizona 85285-8372.

**Table 1. Prevalence and mean intensity of cystacanths of *Polymorphus spindlatus* infecting 2 body cavity sites of *Orestias* spp., Lake Titicaca, Peru, 1991–1993.**

Fish species	Fish infected/ fish examined (%)	Cystacanths (mean/infected fish)	
		Liver	Intes- tinal serosa
<i>O. agassi</i>	47/161 (29)	4	2
<i>O. luteus</i>	15/132 (11)	1	2
<i>O. mulleri</i>	1/3 (33)	3	1
<i>O. olivaceus</i>	1/8 (13)	1	2

include neck, proboscis, or male bursa (which was never extruded). Proboscis hook counts involved at least 2 complete and adjacent rows of hooks; the largest 2 hooks in perfect profile of each specimen were measured.

Male and female cystacanths were deposited at the U.S. National Museum, Beltsville, Maryland, Helminthological Collection, No. 84237 and the University of Nebraska State Museum Manter Laboratory Collection, No. 37935.

Of the 43 native species of killifish, genus *Orestias*, known from the Lake Titicaca basin (Parenti, 1984), at least 15 are endemic to the Altiplano and Lesser Lake Titicaca, Peru–Bolivia (Lauzanne, 1982). Four species from the latter population were examined for parasites (Table 1). All species appear to maintain stable reproductive populations throughout the year and show no seasonal variation (Loubens and Sarmiento, 1985; Loubens, 1989). The most frequently and heavily infected species, *O. agassi* Valenciennes, 1846, is also the most abundant and commercially important species in the lake. It inhabits the pelagic zone and is plentiful in the entire lacustrine plant belt. It has a varied diet (Loubens et al., 1984; Loubens and Sarmiento, 1985). *Orestias luteus* Valenciennes, 1846, and *O. olivaceus* Garman, 1895, are perimacrophytic benthos feeders that are also plentiful in the vege-

tation belt (Loubens et al., 1984; Loubens, 1989). *Orestias mulleri* Valenciennes, 1846, typically inhabits the benthic part of the medium depth area of the lake (Loubens et al., 1984). No intestinal parasites were detected.

Worms infected liver capsules more frequently than the intestinal serosa (Table 2). The lower prevalence of infection in *O. agassi* and *O. luteus* from Puno Bay compared to the open deeper waters (Table 2) may reflect heavier predation on infected Bay fishes by the definitive host.

The following description of male and female cystacanths of *P. spindlatus* (Figs. 1, 2) from their fish paratenic hosts is based on a complete morphometric study of 10 males and 16 females.

**GENERAL DESCRIPTION:** Spindle-shaped trunk and proboscis. Proboscis hooks similar in size in both sexes but double-walled proboscis receptacle and clavate lemnisci larger in females than in males. Proboscis with 16–18 rows of 11–13 hooks each; largest hooks at expanded center. Lemnisci shorter than proboscis receptacle. Anterior trunk spines very small, in 5–8 circles. Hypodermal nuclei prominent and extend into zone of trunk spines. Male and female reproductive systems not well developed but posterior invaginations large; reproductive openings terminal.

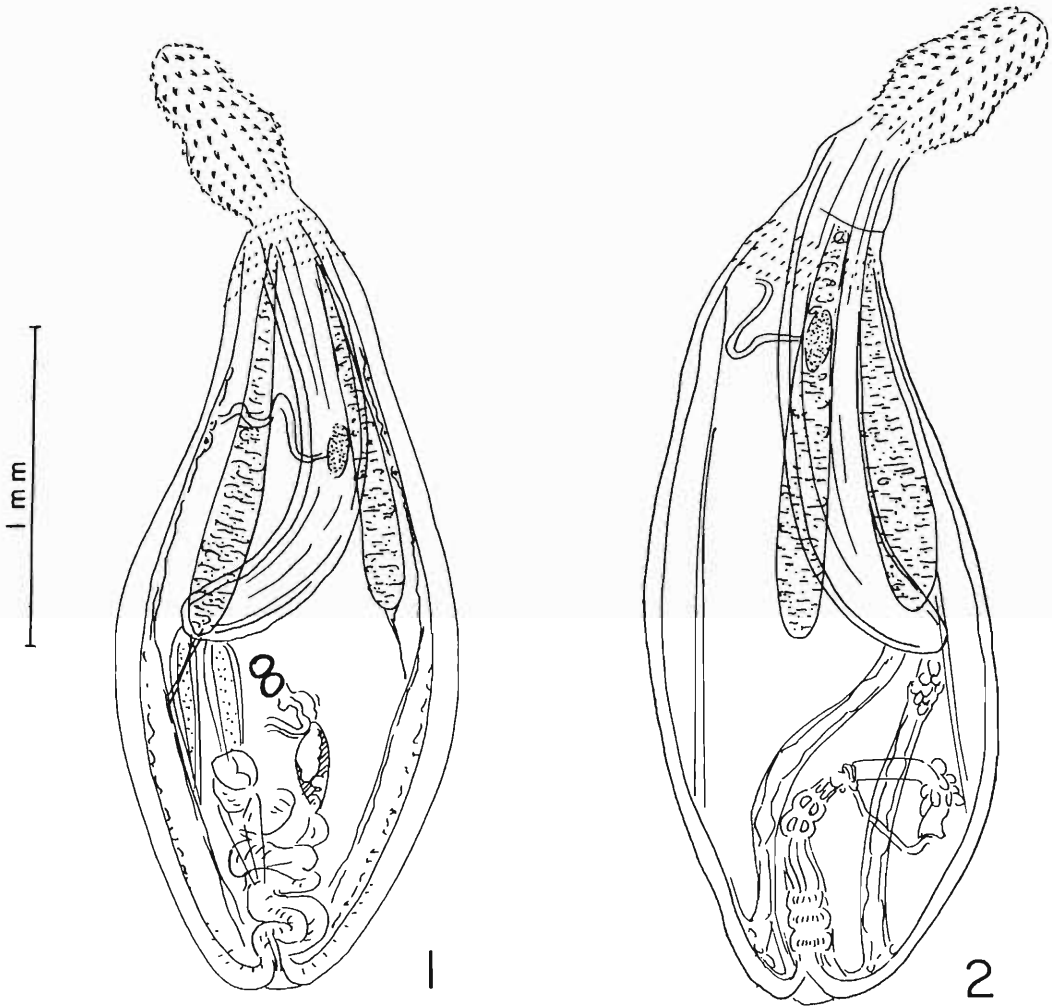
**DESCRIPTION OF MALES:** Trunk 1.92–2.56 (2.26) mm long by 0.77–1.12 (0.98) mm wide. Proboscis 672–770 (707) long by 266–308 (285) wide. Largest proboscis hooks 54–64 (59) long. Proboscis receptacle 1,120–1,512 (1,370) long by 238–280 (252) wide. Lemnisci 840–1,190 (1,032) long by 70–266 (161) wide. Very small, ovoid-spheroid, contiguous, nearly oblique testes in ligament sac; anterior testis 56–98 (79) long by 58–84 (68) wide and posterior testis 70–91 (80) long by 56–84 (71) wide. Posterior end of reproductive structures and bursal muscles unusually enlarged and never extruded.

**DESCRIPTION OF FEMALES:** Trunk 1.61–3.01 (2.38) mm long by 0.77–1.16 (1.01) mm wide. Proboscis 616–780 (709) long by 220–332 (292)

**Table 2. The effect of locality on infection of body cavity sites of *Orestias agassi* and *O. luteus* with cystacanths of *Polymorphus spindlatus*.**

Fish species	Puno Bay		Open deep waters		Total
	Intestinal	Hepatic	Intestinal	Hepatic	
<i>O. agassi</i>	0/50 (0)*	5/50 (10)	4/50 (8)	34/50 (68)	43/100 (43)
<i>O. luteus</i>	0/50 (0)	3/50 (6)	1/50 (2)	9/50 (18)	13/100 (13)
Total	0/100 (0)	8/100 (8)	5/100 (5)	43/100 (43)	56/200 (28)

\* Fish infected/fish examined (%).

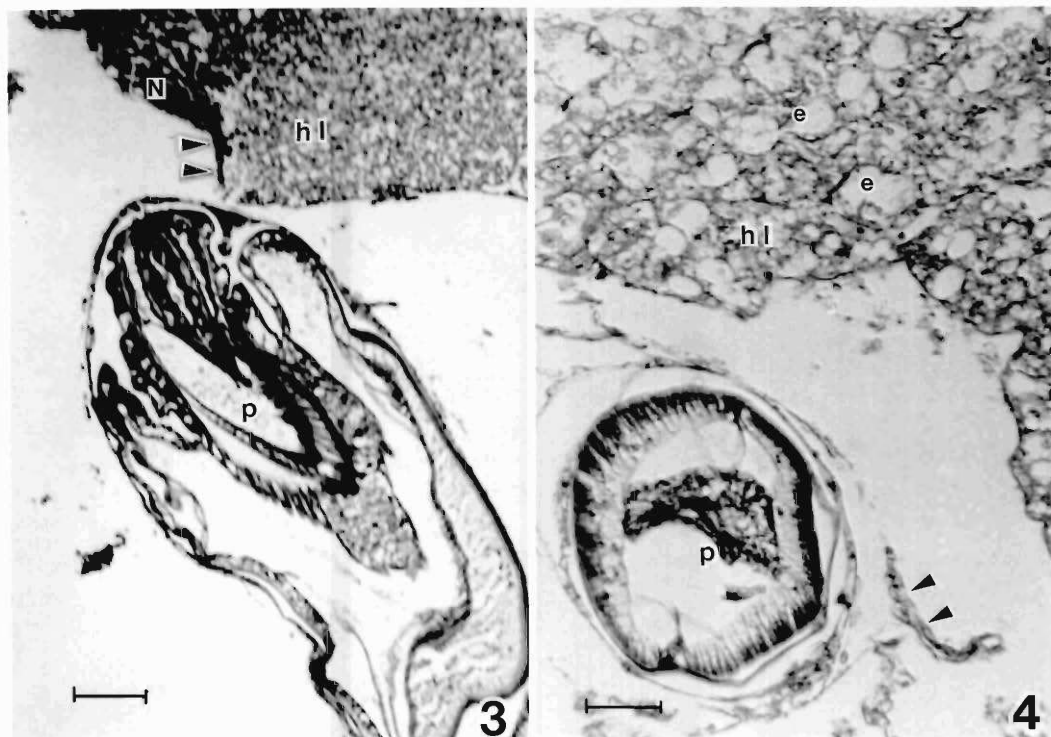


Figures 1, 2. Cystacanths of *Polymorphus spindlatus* from liver surface of their paratenic hosts of the genus *Orestias*. 1. Male cystacanth. 2. Female cystacanth.

wide. Largest proboscis hooks 54–64 (57) long. Proboscis receptacle 1,330–1,680 (1524) long by 252–336 (274) wide. Lemnisci 902–1,470 (1245) long by 98–280 (183) wide. Uterus and uterine bell small but distinct, and vagina asymmetrical and greatly enlarged. Only very few and minute ovarian balls may be present in ligament sacs.

The pattern of proboscis armature and trunk spines in cystacanths of *P. spindlatus* is the same as that of the adults. The trunk is about half as long as that of the adults, and there is less sexual dimorphism in the cystacanths than in the adults. The proboscis and proboscis hooks are practically identical in size and shape to those of the adults. The proboscis receptacle, however, is dis-

tinctly longer than in adults of both sexes. Growth in size of trunk and lemnisci as well as development of the reproductive structures appear to be slower than those of other structures. Cystacanths are clearly not precocious and must undergo marked reproductive development in the definitive host. Developmental priorities are apparently placed on attachment structures to secure successful establishment in the fish-eating avian definitive host, *N. nycticorax*. The state of development of *P. spindlatus* in the intermediate host is unknown, but it would be interesting to see whether or not the degree of development of attachment structures is comparable to that observed in the paratenic hosts. All worms exam-



Figures 3, 4. Histopathology of *Polymorphus spindlatus* cystacanths in the liver of *Orestias agassi*. 3. Parasite (p) adjacent to host liver tissue (hl) causing necrosis (n) and liver capsule separation (double arrowheads). 4. A cross-section of the trunk of a parasite (p) next to host liver (hl). Note the disruption of the liver capsule with necrotic cells (arrowheads). The encasement of the cystacanth in a hyaline envelope is visible. Edematous hepatocytes (e) are seen within hepatic lobules (hl) (trichrome stain). Scale bars = 500  $\mu$ m.

ined were in excellent condition and were probably viable upon recovery from their hosts. *Orestias* spp. clearly serve as an indispensable link in the natural infectious cycle of *P. spindlatus* between the intermediate crustacean host and the piscivorous definitive host.

Other cystacanth features that differ significantly from those of adults include the minute size of trunk spines, the marked enlargement of vaginal and bursal invaginations, and the lemnisci being shorter than the proboscis receptacle. The neck is not as well developed, as indicated in the original description of adults.

Cystacanths were often found beneath the liver capsule of *Orestias* spp. (Fig. 3). Worms do not appear to move into the hepatic lobules but remain on the surface. Encapsulation often involved formation of a hyaline envelope (Fig. 3). The trunk of the specimen in Figure 4 was also encapsulated adjacent to hepatic lobules of *Orestias*. Damage to the hepatocytes immediately next to cystacanths included necrosis (Fig. 3),

edematous liver cells (Fig. 4), and disruption of the capsule surrounding the liver (Fig. 4). Parasites were readily detachable by breaking the dense collagenous connective tissue capsule surrounding them. All worms sectioned had retracted proboscides.

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## Research Note

# Histopathology of *Oligacanthorhynchus tortuosa* (Oligacanthorhynchidae) Infection in the Virginia Opossum (*Didelphis virginiana*)

DENNIS J. RICHARDSON AND EARL B. BARNAWELL

School of Biological Sciences, University of Nebraska, Lincoln, Nebraska 68588-0118

**ABSTRACT:** *Oligacanthorhynchus tortuosa*, a common acanthocephalan of the Virginia opossum (*Didelphis virginiana*) in North America, has been reported to be associated with large, nodule-like lesions at points of attachment of the proboscides. Three lesions resulting from the attachment of individuals of *O. tortuosa*, 1 each from 3 infected opossums, were prepared for histological examination to further characterize histopathologic changes elicited by this parasite. Histologically, lesions involved the mucosa, submucosa, and muscularis. The proboscides were contained within abscesses characterized by necrotic debris interspersed with many pycnotic nuclei. The abscesses were approximately 1.4 mm in diameter and were surrounded by regions of dense connective tissue (collagen), approximately 142  $\mu$ m wide. The bands of dense connective tissue were surrounded by regions of active fibroblast and fibrocyte proliferation, approximately 169  $\mu$ m wide, in which evidence of collagen synthesis was observed. Both longitudinal and smooth muscle layers of the muscularis had been completely destroyed in the area of the lesion. Absence of polymorphonuclear leukocytes were indicative of chronic lesions. Histopathologic changes elicited by *O. tortuosa* include chronic inflammatory response to mechanical trauma resulting from injury caused by the proboscis with subsequent fibrosis and nodule formation.

**KEY WORDS:** histopathology, *Oligacanthorhynchus tortuosa*, *Didelphis virginiana*, opossum, Acanthocephala.

*Oligacanthorhynchus tortuosa*, a common acanthocephalan of the Virginia opossum (*Didelphis virginiana*) in North America, has been reported to be associated with large, nodule-like lesions at points of attachment of proboscides. *Oligacanthorhynchus tortuosa* is represented by large worms with females achieving lengths of up to 350 mm (Richardson, unpubl. data). The

globular proboscis bears 6 spiral rows of 6 hooks each and has a length of 0.22–0.23 mm and width of 0.23–0.29 mm (Van Cleave, 1953). Leidy (1850) reported a specimen of *O. tortuosa* as having the anterior 3 lines of its length buried in an oval tumor, 4 lines in diameter, in the mesentery of an opossum. Based on this statement, Van Cleave (1924) concluded that the worm had penetrated the intestinal wall, entered the body cavity, and attached to the mesentery. Feldman et al. (1972) reported severe ulcerative lesions evoked at points of attachment of unidentified acanthocephalans from opossums. Brief description and a photomicrograph (Feldman et al., 1972) suggest that these specimens were *O. tortuosa*. Richardson et al. (1992) reported 2 poorly developed individuals of *O. tortuosa* from the small intestine of a raccoon (*Procyon lotor*) that caused "severe lesions" at points of attachment; however, histological examination was not conducted. The only histological examination of lesions caused by *O. tortuosa* was conducted by Babero (1957), who reported elevated nodules over the serosal surface of the small intestines of 2 Illinois opossums having a base diameter of 2–7 mm. He reported the nodules to have a bright red appearance due to congestion of intestinal blood vessels. Histologically, lesions reported by Babero (1957) resulted in complete mechanical destruction of the mucosal and submucosal layers with some focal atrophy and necrosis of the muscularis. He further noted limited leukocytic infiltration and some pigment deposition. Babero (1960) examined opossums from Georgia